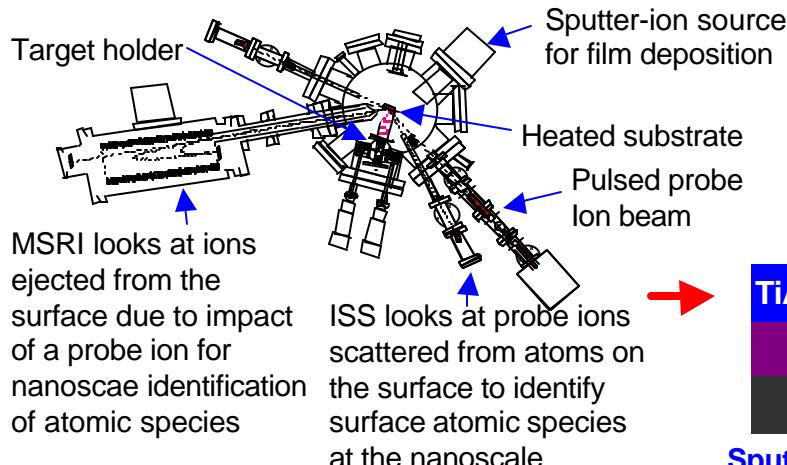
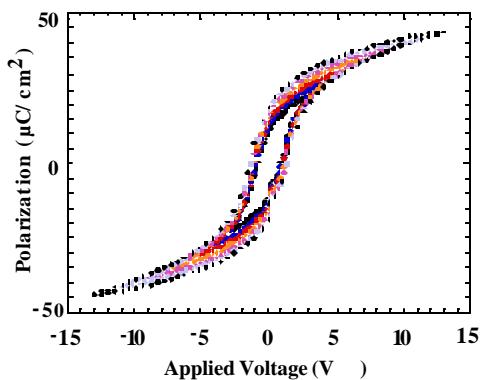


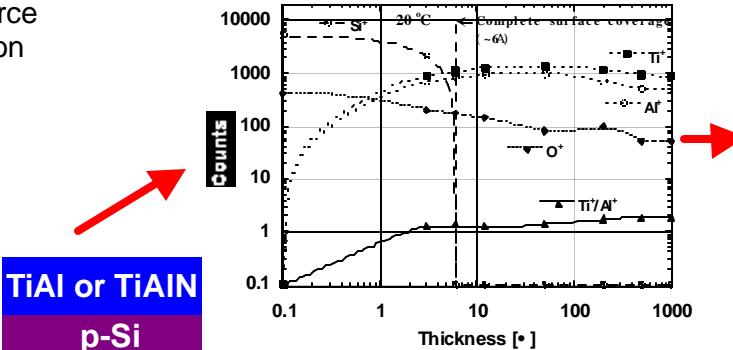
Studies of Oxide Film Growth / Oxide-Metal Interface Processes via *In Situ* / *Ex Situ* Analytical Techniques



Time-of-flight ion scattering spectroscopy (ISS) and mass spectrometry of recoil ions (MSRI) techniques, developed at ANL, enabled *in situ* studies of film growth and interface processes at pressures 4-7 orders of magnitude higher than in conventional surface analytical techniques

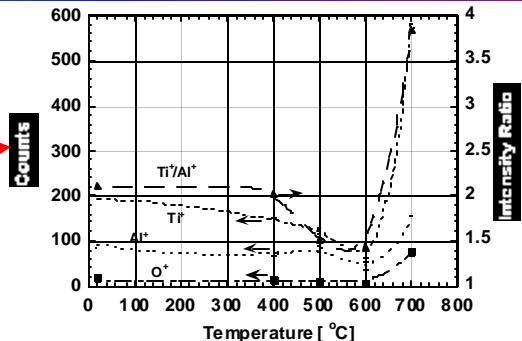


***Ex situ* electrical characterization of LSCO/ PZT/ LSCO/a-TiAl capacitor on Si shows excellent ferroelectric properties for application to NVFRAMs**

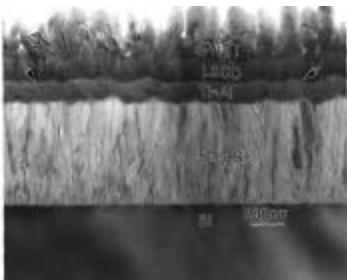


Sputter- deposition of amorphous a-TiAl or a-TiAlN diffusion barrier on Si substrate

***In situ* MSRI shows full coverage of Si substrate at about 9 \AA of TiAl layer growth (Si signal falls to zero; Ti & Al signals reach saturation)**



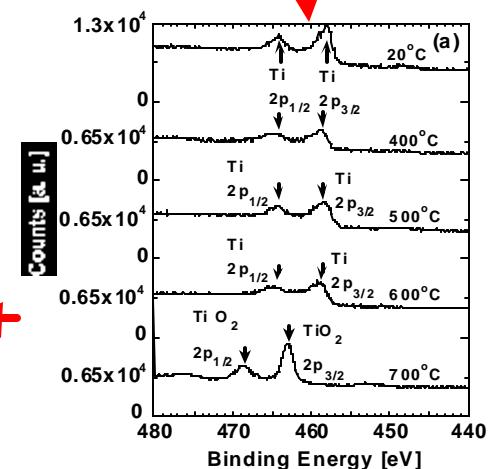
***In situ* MSRI shows that a-TiAl layer does not oxidize (Ti/Al peak do not increase) until > 600 °C in oxygen**



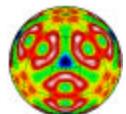
***Ex situ* cross-section TEM reveals sharp/clean interfaces in LSCO/PZT/ LSCO/a-TiAl hetero-structure capacitor on Si**



Conductive oxide $\text{La}_{0.5}\text{Sr}_{0.5}\text{CoO}_3$ electrode is grown on a - TiAl layer followed by PZT / LSCO electrode to complete the Ferroelectric capacitor on Si



***In situ* XPS analysis confirms that the a-TiAl layer oxidizes at > 600 °C via segregation of Ti nano-layer on surface and TiO_2 formation**



Basic Energy Sciences



ANL-MSD

**Surface Chemistry (57504) and Interfacial Materials (58305) Groups
Materials Science Division**